ERDC MSRC PET Technical Report No. 01-23

SPEEDES Installation and Training at ERDC MSRC

by

Wojtek Furmanski

16 May 2001

Work funded by the Department of Defense
High Performance Computing Modernization Program
U.S. Army Engineer Research and Development Center
Major Shared Resource Center through

Programming Environment and Training

Supported by Contract Number: DAHC94-96-C0002
Computer Sciences Corporation

PET Year 5 Technical Report

SPEEDES Installation and Training at ERDC MSRC

Wojtek Furmanski

Department of Electrical Engineering and Computer Science
Syracuse University

Technical Support Personnel: Year 5 PET FMS was a single-person effort, conducted by Wojtek Furmanski at Syracuse University as a continuation and completion of a larger PET FMS program previously pursued by NPAC.

Year 5 Accomplishments: The ERDC MSRC supported one focused effort in the FMS area during Year 5. The ERDC project was focused on *SPEEDES Installation and Training at ERDC MSRC*. As part of this project, the following tasks were performed:

- Tracking SPEEDES technology and business;
- Development of SPEEDES Training materials;
- Delivery of SPEEDES tutorial at ERDC MSRC;
- Installation of SPEEDES at Origin3000 at ERDC MSRC.

Syracuse had prior experience with SPEEDES (Synchronous Parallel Environment for Emulation and Discrete-Event Simulation) while the system was under development by FMS CHSSI at Metron Corporation in San Diego, Calif. Syracuse provided assistance to SPEEDES-based CHSSI FMS projects such as SPEEDES-based Parallel NSS (Navy Simulation System) or Parallel IMPORT, and successful installations of early versions of SPEEDES (v0.6-0.9) on the Origin2000 systems at ERDC, ARL, and NRL were performed. Sample performance results for Parallel NSS are illustrated in Fig. 1.

Parallel NSS Performance (100,000 Objects)

n = number of nodes	CPU	wall	CPU/wall	t1/tn
1				
2				
4				
8				
16				
32	45503.1	1468.22	30.99	
64	44035.1	736.185	59.82	
96	47152.8	543.64	86.73	

59

Fig 1: Sample parallel run of SPEEDES v0.7-based Parallel NSS system on Origin2000 in NRL, performed by PET FMS as part of beta testing FMS CHSSI codes.

SPEEDES, viewed as a programming framework, represents a mature parallel event-driven simulation technology. It originated from the Caltech/JPL Time Warp R&D activity in the early 1990s. However, SPEEDES as a software system is continuously evolving as new concepts are added to the system and new sponsors and partners join the SPEEDES community. The SPEEDES historical timeline over the past decade is illustrated in Fig. 2. As shown, the main support for SPEEDES over the past few years was provided by the WG2K (Wargame2000) project at the JNTF (Joint National Test Facility), Colorado Springs, and by FMS CHSSI projects within the HPC Modernization Program.

Last year, SPEEDES was adopted by JSIMS as the core simulation engine. As part of this focused effort, the complex transition process of SPEEDES to JSIMS was monitored. This was initiated by Jeff Wallace (SPAWAR, San Diego and Technical Director of JSIMS Maritime) and David Pratt (JSIMS Technical Director). SPEEDES is a Government-owned (NASA) software system for which Metron Corp. had a special development license. Until JSIMS got involved in SPEEDES, the system was under continuous development at Metron in San Diego, with support from WG2K and HPCMO that brought the system to the v 0.9 release in the fall of 2000. However, JSIMS selected another San Diego company, RAM Labs, to continue support for the JSIMS version of the system. Consequently, there are now two versions of SPEEDES: the Metron version

sponsored by the JNTF and the RAM Labs version sponsored by JSIMS enterprise and CHSSI FMS-5.

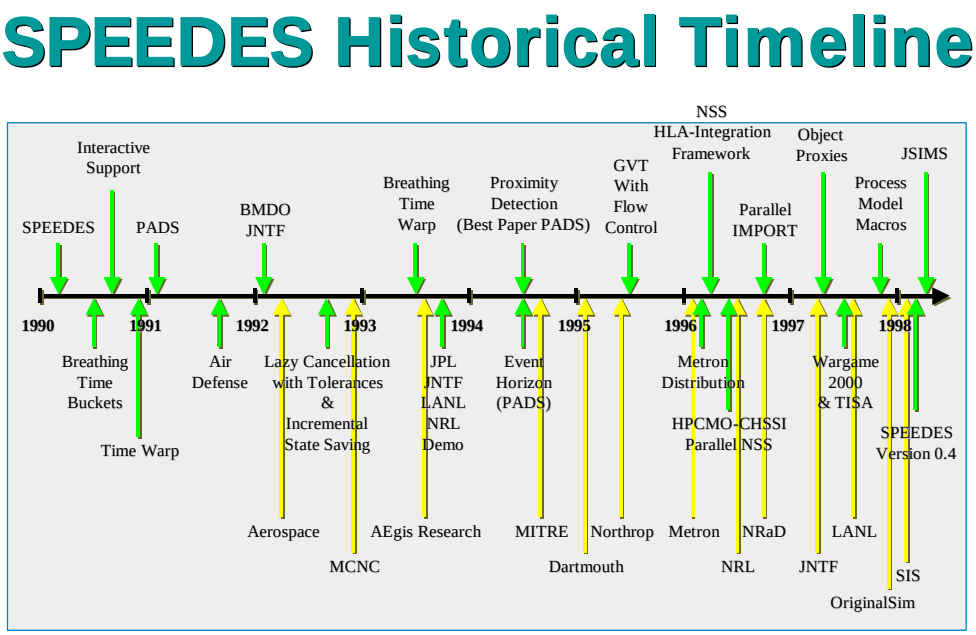

Fig. 2: A sequence of events, technologies and players contributing to the evolution of the SPEEDES system over the last decade. The system was created at Caltech/JPL in early '90s, continued by Metron Corp. in mid/late '90s and finally taked over by JSIMS in 2000.

As part of the Year 5 focused effort, contacts were established with both companies. Both versions of the system were received, the available documentation was analyzed, and source level analysis of the similarities and differences between the two versions was performed. Major players in the SPEEDES domain were consulted, and a strategy for the Year 5 SPEEDES training development and delivery was developed. Since the current (early) JSIMS version offers support only for Solaris and Linux, whereas the (more mature) Metron version offers a genuine multi-platform support (including IRIX), the Metron version was selected as the tentative target for Year 5 training. A suite of 10 tutorial applications, distributed as part of the Metron release, was analyzed and adapted for the ERDC training needs. However, new emergent features of the JSIMS version (such as Federation Objects) were covered, and some of the JSIMS tutorial examples were converted to the Metron version. A SPEEDES Tutorial was delivered at ERDC MSRC in March 2001 and the Metron version of the system was installed on the Origin3000 at ERDC. A port of the JSIMS version of SPEEDES to the SGI Origin platform is in works.

Tutorial Organization: The SPEEDES tutorial was packaged as six lectures, about one hour each, addressing the following topics:

1. Introduction and Overview of SPEEDES and PET FMS;

2. Concepts, Challenges, and Algorithms of Parallel Discrete-Event Simulations (PDES);
3. SPEEDES Modeling Framework;
4. Distributed Object Management;
5. Simulation Infrastructure and Programming Utilities;
6. SPEEDES Status and Follow-on Training Options.

Each lecture was organized as approximately 60 PowerPoint slides. Lectures 1, 2, and 6 were less technical, while Lectures 3, 4, and 5 included hands-on analysis of the SPEEDES C++ code samples.

SPEEDES is a complex system, and as such a SPEEDES tutorial is challenging. The full coverage of the system architecture and modules, depicted in Fig. 3, would likely require a one-semester college level course. In the tutorial, developed and delivered as part of this project, the focus was on essential features of parallel event-driven simulation technology that underlies SPEEDES, such as the Breathing Time Bucket Algorithm illustrated in Fig. 4. The main concepts and programming techniques in a suite of software examples, released by Metron as part of SPEEDES 1.0 release, are illustrated.

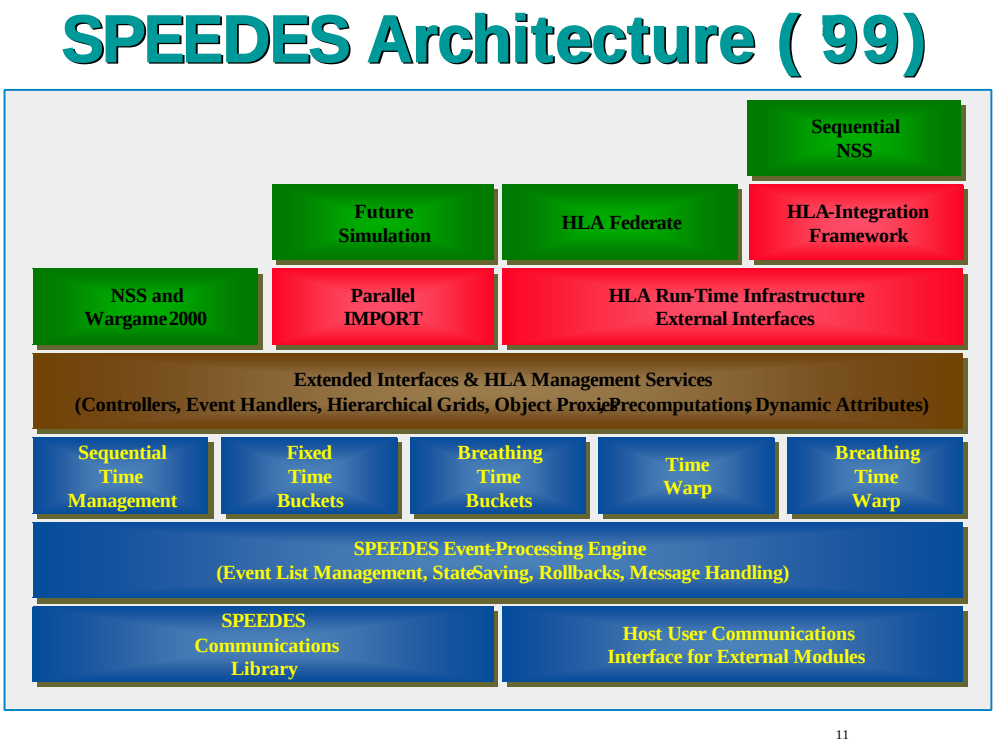

Fig. 3: Overall architecture of SPEEDES: Main layers include communication libraries, Event-driven Simulation Engine, a suite of time management algorithms, and a suite of high-level facilities, services and application modules such as Paralell NSS, WG2K, Parallel IMPORT, and HPC RTI, etc.

SPEEDES Installation and User Support: The SPEEDES framework was exposed to ERDC MSRC users as part of one-day tutorial delivered on March 22 at ERDC. Initial

installation on the ERDC MSRC Origin3000 was accomplished in March/April 2001 and is to be continued throughout the summer of 2001 in the extension of this project. So far, only the Metron version SPEEDES 1.0 has been installed since the JSIMS version does not support IRIX. However, JSIMS tutorial samples were converted to the Metron version and installed at ERDC MSRC. This way, the FMS users at ERDC can get an early preview of and insight into the emergent JSIMS version of the system, using the currently more stable and mature Metron version.

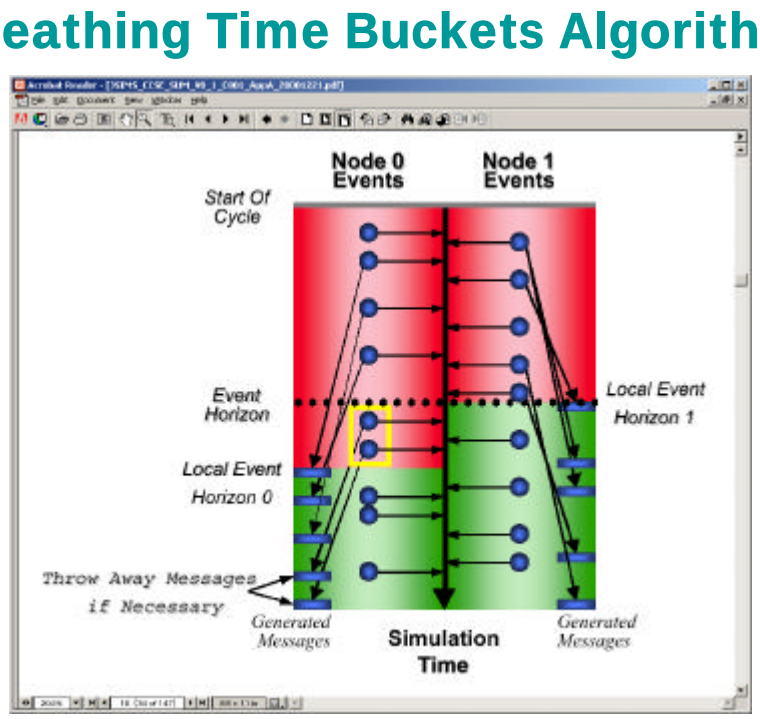

Fig. 4: Pictorial representation of the core algorithmic concepts of SPEEDES such as Event Horizon, Rollback, Time Warp, Time Buckets, Breathing Time Bucket, and Breathing Time Warp algorithms. The latter offers an optimal balance between risky, high speedup but low stability Time Warp and the more conservative but lower performance Breathing Time Bucket Algorithm.

A potential SPEEDES user at ERDC was identified during the training session. This person was trying to explore the Metron version of the system and had problems understanding its relation to JSIMS and the status of the software; The tutorial and insight into the SPEEDES status directly helped clarify these ambiguities. It turns out that the FMS users today are again looking for a new stable and sustainable M&S platform to be used as a base for their application codes. ModSAF is no longer a viable candidate for such core system due to its slow transition from DIS to HLA. As a result, SPEEDES/JSIMS is being evaluated as a potential new base platform candidate. SPEEDES has great potential, and it is believed that this system, when backed by JSIMS, might indeed become a new DoD-wide standard for M&S. SPEEDES offers a

sophisticated HPC Engine for object-oriented (C++) event-driven (logical time) simulations, it uses the Breathing Time Warp algorithm to manage simulation state rollback and to assure stability and to optimize speedup. It is a state-of-the-art parallel simulation technology of relevance for FMS, capable of processing millions of dynamic interacting entities in a wide range of time scales and simulation parameters. The interaction with ERDC FMS users initiated during the SPEEDES tutorial session will continue, and possible joint projects in which further assistance can be provided with hands-on software engineering in the SPEEDES programming environment will be explored.

Related Efforts and Next Steps:A CHSSI FMS-5 project that develops SPEEDES-based RTI is also taking place. In previous PET projects, an early Web-based implementation of a DMSO HLA/RTI simulation software infrastructure called WebHLA was developed. The original implementation was based on Java/CORBA and is now porting the system to the new, promising .NET framework being introduced by Microsoft. .NET is a major multi-billion dollar effort at Microsoft that will likely impact several aspects of distributed computing and Web-based computing in coming years. As part of this project, SPEEDES-based HPC RTI will be integrated with .NET-based WebHLA. Such a merger, illustrated in Fig. 5, will enable seamless delivery of remote HPC simulations to DoD users, regardless of the specific front-end computers they use, be it a UNIX workstation, a PC, or a mobile hand-held device.

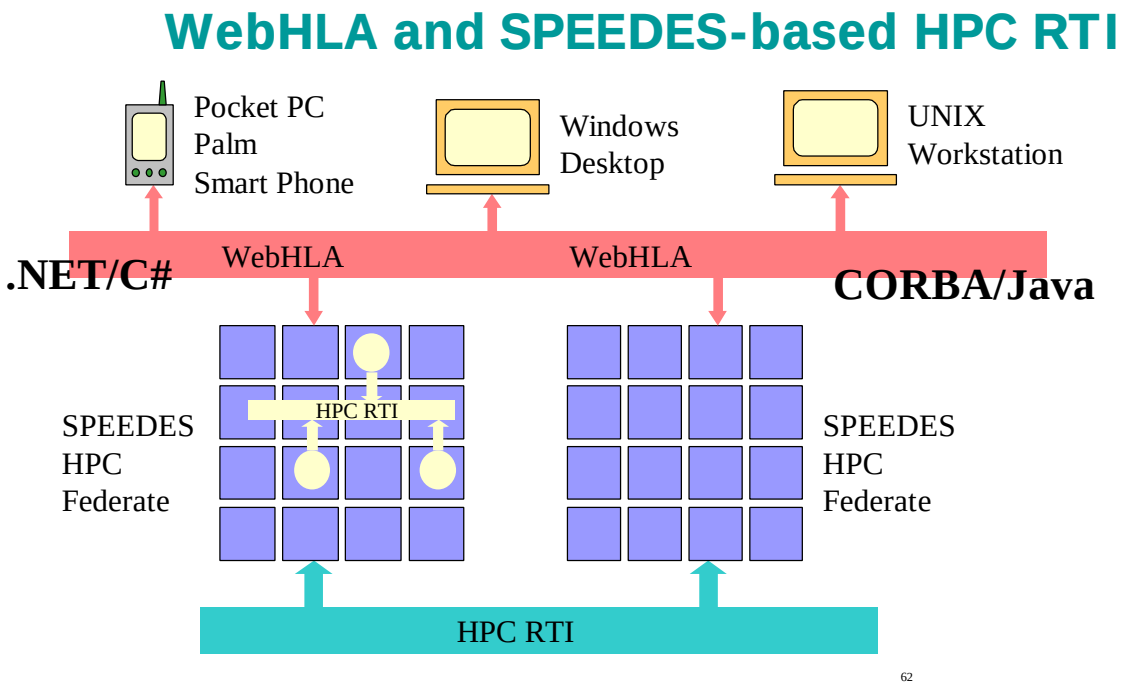

Fig 5: SPEEDES – WebHLA integration framework under development as part of CHSSI FMS-5. SPEEDES-based HPC RTI will support HPC federations that include several HPC systems running SPEEDES-based federates and communicating via dedicated, high bandwidth HPC RTI bus. The associated WebHLA bus will support lower bandwidth higher functionality seamless access to HPC resources from a variety of front-end systems.